

TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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No. 317

TESTS OF FOUR RACING TYPE AIRFOILS IN THE TWENTY-FOOT
PROPELLER RESEARCH TUNNEL

By Fred E. Weick
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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

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Summary

Tests were made at the request of the Bureau of Aeronautics, Navy Department, on four racing type airfoils of 3-foot chord and 12-foot span in the 20-foot air stream of the Propeller Research Tunnel at 100 m.p.h., in order to determine the high speed characteristics of the wings. The airfoil sections tested were the N-9, N-38, C-62, and the N-46, which is a C-62 with rounded leading edge. The results indicate that the N-46 has about 12 per cent lower minimum drag than the regular C-62 section, and that both the N-38 and the N-46 have the exceptionally low minimum drag coefficient $C_{Dmin} = .0073$.

T e s t s

Tests of the high speed aerodynamic characteristics of four racing type airfoils were made in the 20-foot air stream of the Propeller Research Tunnel (Reference 1), at the request of the Bureau of Aeronautics, Navy Department.

The airfoils tested were the N-9, N-38, C-62, and the N-46. The shapes of these sections are shown in Figures 3-6,

and the dimensions are given in Table I. The N-9 section was obtained from the Göttingen 398 by reducing all of the ordinates (based on the chord line) in the same proportion, and the N-38 was obtained in the same manner from the R.A.F. 25 excepting that the ordinates were increased instead of decreased. The wind tunnel models had a span of 12 feet and a chord of 3 feet, with the exception of the N-46, which was made by cutting down the original sharp nose of the C-62 airfoil, leaving the chord 2.974 ft. instead of 3 ft. The dimensions were accurate to within about $1/32$ inch. The airfoils were built up of wood, the leading and trailing edges being of solid laminated construction and the central portion being covered with $1/8$ inch plywood. Figure 1 is a photograph of a completed airfoil.

With the airfoils mounted in the tunnel as shown in Figure 2, the lift and drag forces were measured at an air velocity of approximately 100 m.p.h., and at angles of attack varying by 1-degree intervals from that for zero lift to +4 degrees. Since only the high-speed characteristics of the wings were desired, it was unnecessary to run the tests at higher angles of attack, and thus it was possible to use relatively small supports having very low tare drag. In fact, the tare drag was only about 8 per cent of the lowest drag measured for any of the wings. In making the tests, four readings were taken at each angle of attack.

The tests were run at a Reynolds Number of about 2,800,000 which is something over three-fourths of that obtained in the

Variable Density Tunnel at 20 atmospheres pressure with the usual 5-inch chord airfoil. Judging from tests on scale effect made in the variable density tunnel, the scale of these tests is sufficiently high that further increase of Reynolds Number may be expected to have an almost negligible effect on the aerodynamic force coefficients.

R e s u l t s

The results of the tests are given in the form of polar curves for each of the sections in Figures 3 to 6 inclusive. The values of the lift and drag coefficients and angles of attack obtained from the faired curves are given in Table II. Corrections have not been made for wind tunnel constraint since this is negligible at the low lift coefficients occurring near minimum drag.

The polar curves for all four airfoils are plotted for comparison in Figure 7. The N-38 and the N-46 have the lowest minimum drag coefficient $C_{D_{min}}$ being .0073 for each of these sections. The N-38, however, is very slightly superior at higher lifts. These two sections have considerably lower minimum drag coefficients than the regular C-62 and the N-9, for which the values are .0083 and .0088, respectively. The profile drags are plotted for comparison in Figure 8.

Rounding the sharp nose of the C-62 produced the remarkable reduction of 12 per cent in minimum drag. The polar curves for the C-62 and the N-46, both based on the original area to afford direct comparison, are plotted in Figure 9.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., July 26, 1928.

Reference

1. Weick, Fred E. and Wood, Donald H. : The Twenty-Foot Propeller Research Tunnel of the National Advisory Committee for Aeronautics. N.A.C.A. Technical Report No. 300 (1928).

TABLE I.

Ordinates of Sections in per cent of Chord

N-9			N-38		C-62		N-46		
Per cent of chord	Upper ordinate	Lower ordinate	Upper ordinate	Lower ordinate	Upper ordinate	Lower ordinate	Per cent of chord	Upper ordinate	Lower ordinate
0.0	2.240	2.240	4.350	4.360	0.0	0.0	0.869	0.167	+0.167
1.25	3.715	1.138	5.450	3.210	1.100	-0.700	1.25	0.972	-0.500
2.5	4.500	0.770	5.910	2.760	1.858	-1.069	2.5	1.856	-1.069
5.0	5.520	0.389	6.480	2.160	2.940	-1.530	5.0	2.940	-1.530
7.5	6.220	0.211	6.920	1.750	3.748	-1.765	7.5	3.748	-1.765
10.0	6.740	0.111	7.230	1.438	4.320	-1.920	10.0	4.320	-1.920
15.0	7.520	0.011	7.700	0.947	5.100	-2.025	15.0	5.100	-2.025
20.0	8.010	0.0	7.940	0.624	5.580	-2.035	20.0	5.580	-2.035
30.0	8.280	0.031	8.010	0.216	5.960	-2.010	30.0	5.960	-2.010
40.0	8.010	0.100	7.690	0.025	5.850	-1.930	40.0	5.850	-1.930
45.0			7.370	0.0					
50.0	7.380	0.161	6.980	0.011	5.390	-1.770	50.0	5.390	-1.770
60.0	6.380	0.200	6.030	0.097	4.720	-1.518	60.0	4.720	-1.518
70.0	5.130	0.211	4.800	0.144	3.890	-1.197	70.0	3.890	-1.197
80.0	3.670	0.161	3.380	0.156	2.890	-0.830	80.0	2.890	-0.830
90.0	2.065	0.081	1.835	0.119	1.660	-0.439	90.0	1.660	-0.439
95.0	1.258	0.039	1.128	0.072	0.900	-0.219	95.0	0.900	-0.219
100.0	0.250	0.250	0.180	0.180	0.0	0.0	100.0	0.0	0.0

Based on full chord of C-62

Radii in

Radii in

Radii in

Radii in

Per cent of chord

Per cent of chord

Per cent of chord

Per cent of chord

L.E.=0.750

L.E.=0.395

L.E.=0.0

L.E.=0.869

T.E.=0.25

T.E.=0.180

T.E.=0.0

T.E.=0.0

TABLE II.

N-9				N-38			
	C_L	C_D	C_{D_0}		C_L	C_D	C_{D_0}
-3.5°	-.0200	.0097	.0097	-3.4°	-.0200	.0090	.0090
-3.0°	0.0	.0092	.0092	-2.9°	0.0	.0078	.0078
-2.6°	+.0200	.0089	.0089	-2.4°	+.0200	.0074	.0074
-1.9°	.0600	.0088	.0085	-1.7°	.0600	.0074	.0071
-1.1°	.1000	.0095	.0087	-1.1°	.1000	.0082	.0074
-0.5°	.1400	.0107	.0091	-0.5°	.1400	.0096	.0080
$+0.2^\circ$	.1800	.0123	.0096	$+0.3^\circ$	.1800	.0113	.0086
0.8°	.2200	.0142	.0102	0.8°	.2200	.0134	.0094
1.4°	.2600	.0163	.0108	1.4°	.2600	.0158	.0102
2.0°	.3000	.0191	.0117	2.1°	.3000	.0188	.0114
2.7°	.3400	.0219	.0123	2.9°	.3400	.0224	.0128
3.4°	.3800	.0254	.0135	3.6°	.3800	.0268	.0148

C-62				N-46			
	C_L	C_D	C_{D_0}		C_L	C_D	C_{D_0}
-2.2°	-.0200	.0087	.0087	-1.9°	-.0200	.0082	.0082
-1.7°	0.0	.0084	.0084	-1.5°	0.0	.0077	.0077
-1.3°	+.0200	.0083	.0082	-1.2°	+.0200	.0074	.0074
-0.4°	.0600	.0085	.0082	-0.5°	.0600	.0075	.0072
$+0.4^\circ$	.1000	.0093	.0085	$+0.1^\circ$	.1000	.0084	.0076
1.2°	.1400	.0104	.0087	0.8°	.1400	.0098	.0082
1.8°	.1800	.0120	.0093	1.5°	.1800	.0115	.0089
2.4°	.2200	.0139	.0099	2.4°	.2200	.0138	.0098
3.0°	.2600	.0160	.0104	3.1°	.2600	.0164	.0108
3.8°	.3000	.0194	.0119	3.8°	.3000	.0192	.0117

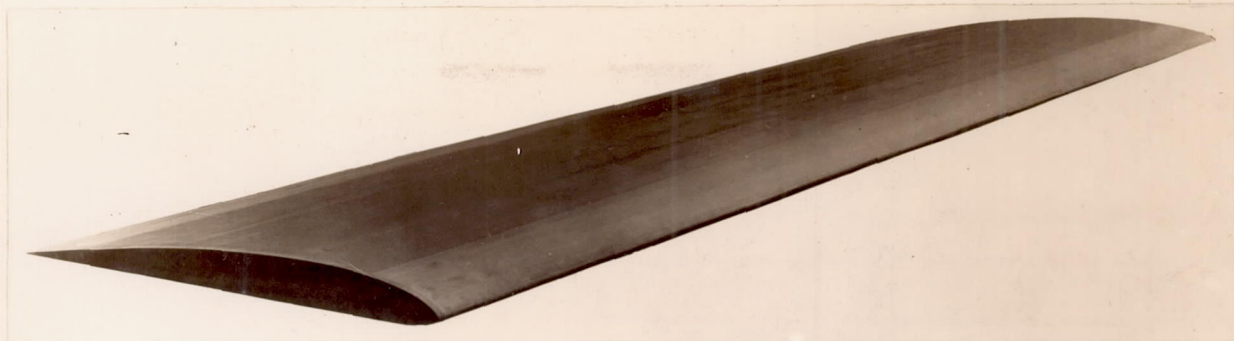


Fig.1 N-9 airfoil, 3' x 12'

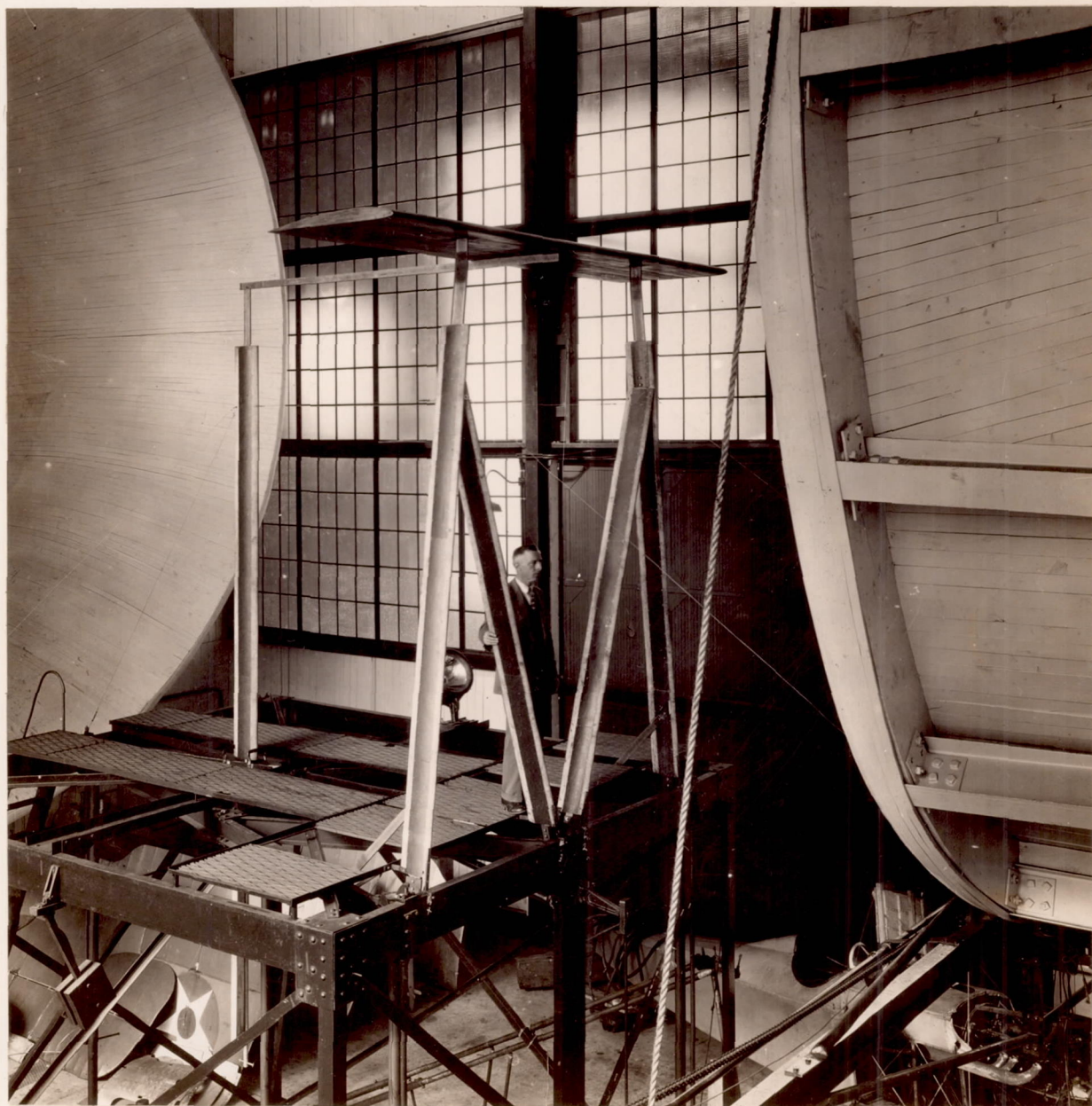


Fig.2 Airfoil mounted on balance

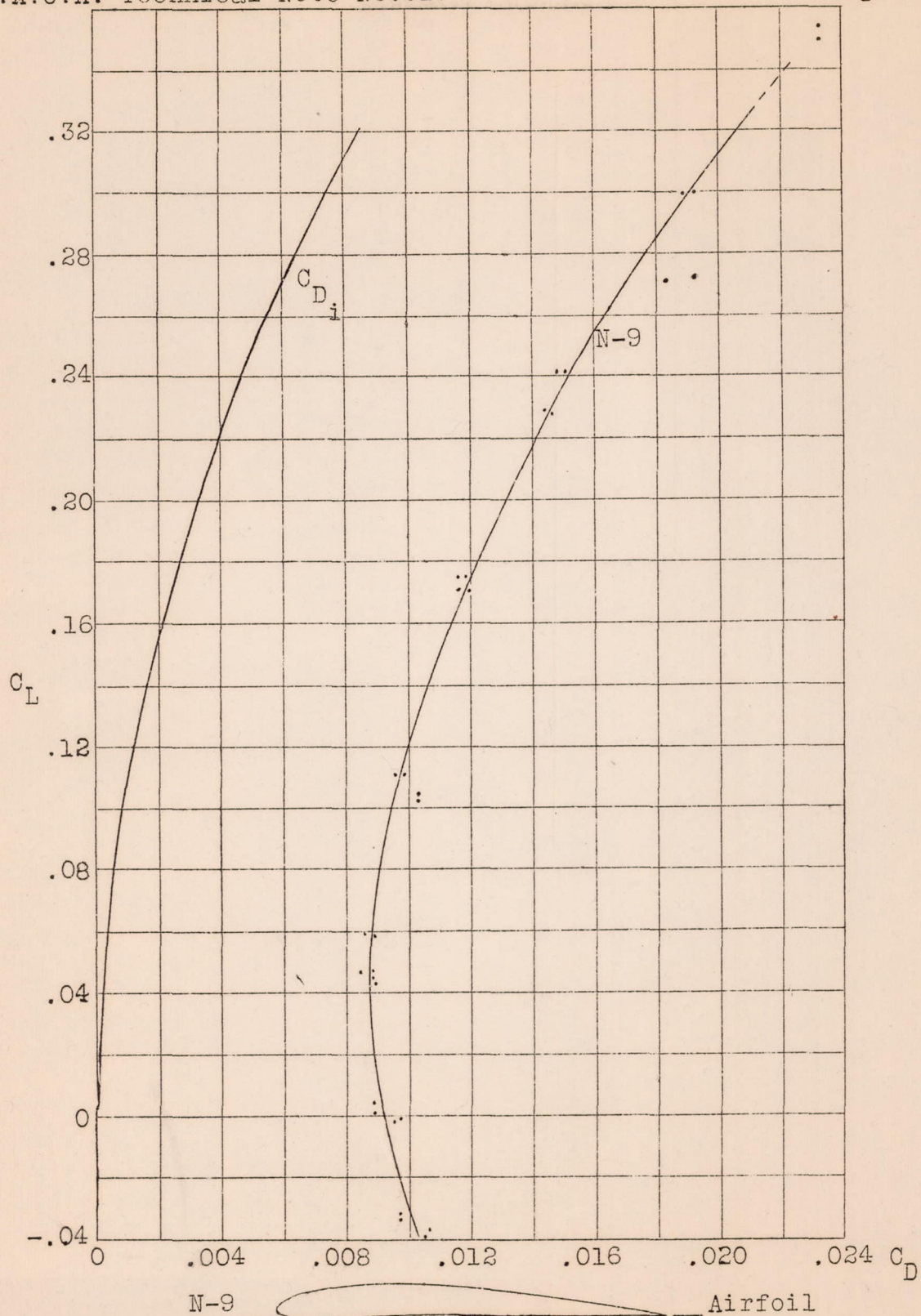


Fig.3

$S = 36$ sq. ft. $A.R. = 4$

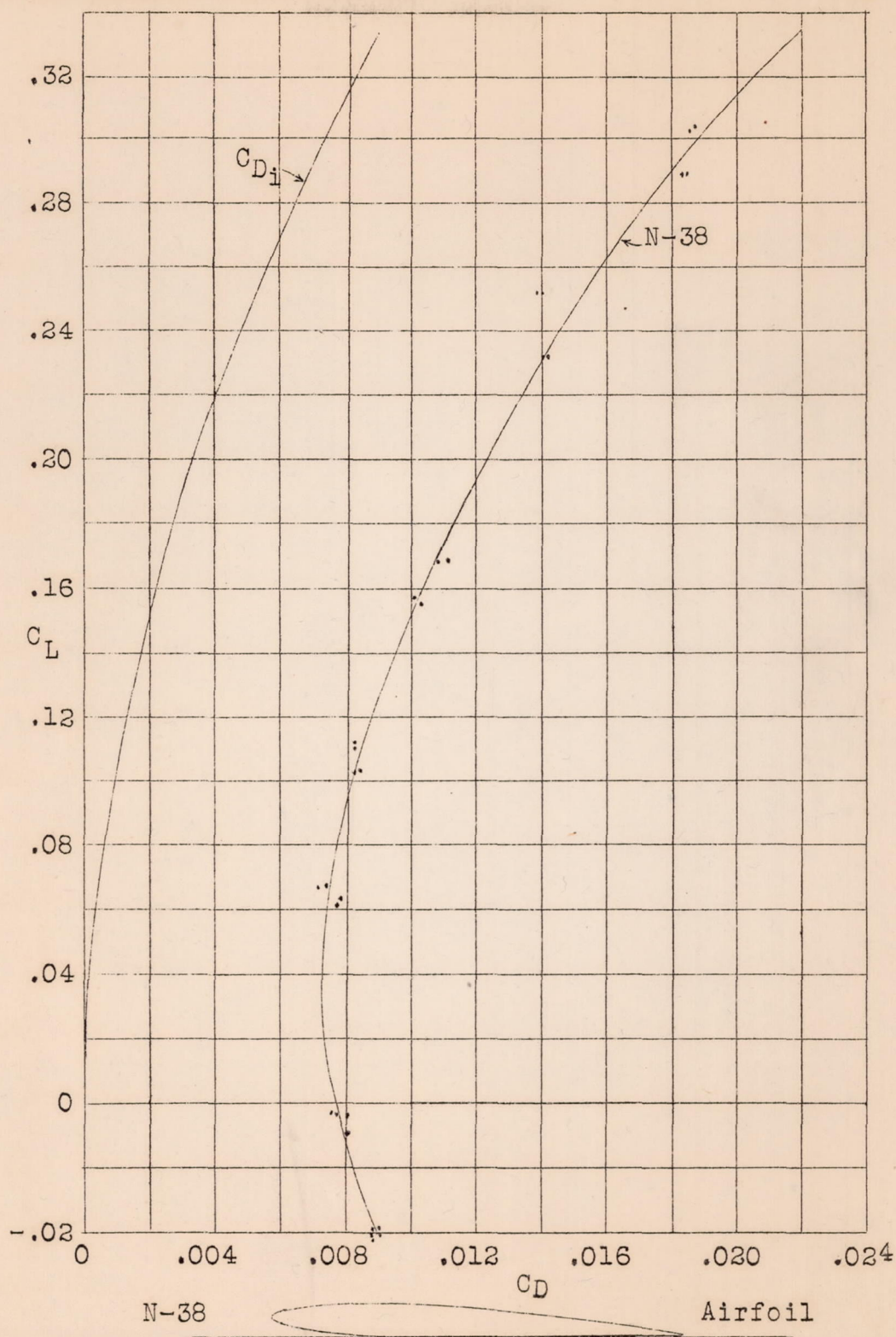
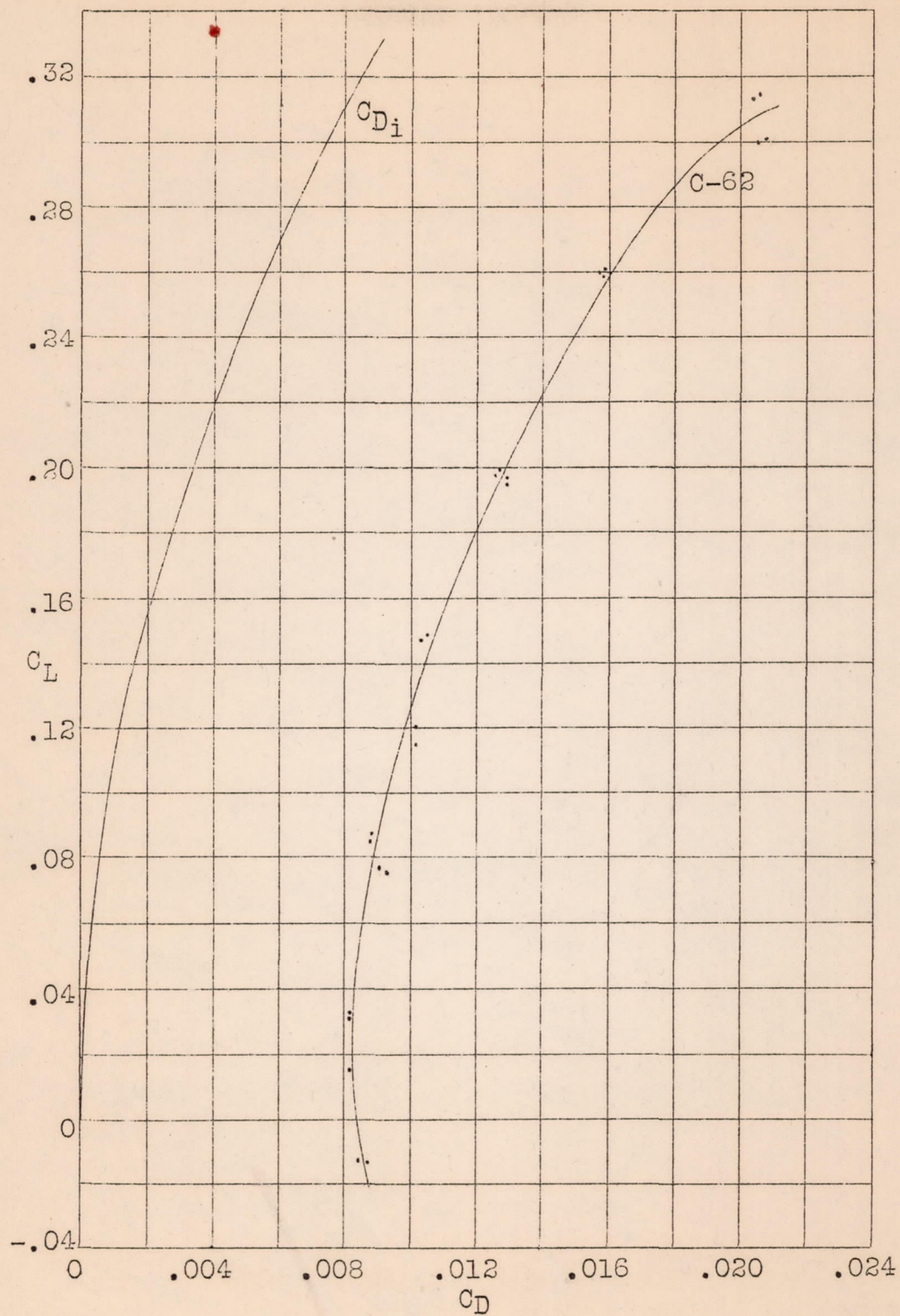


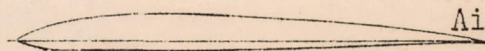
Fig.4

$S = 36 \text{ sq.ft.}$

$A.R. = 4$



C-62



Airfoil

Fig.5

 $S=36$ sq.ft.

A.R.=4

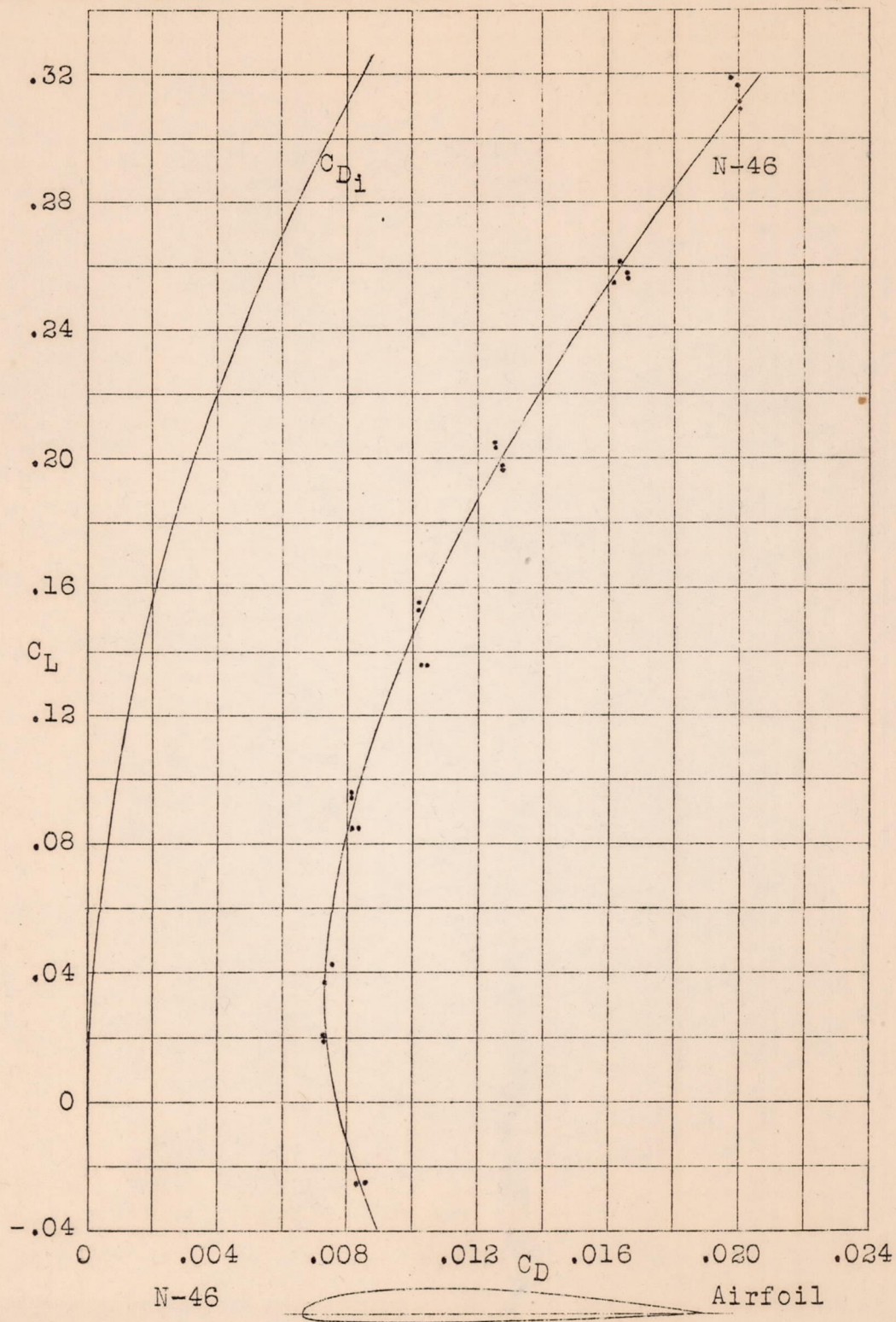


Fig.6

S - 35.69 sq.ft.

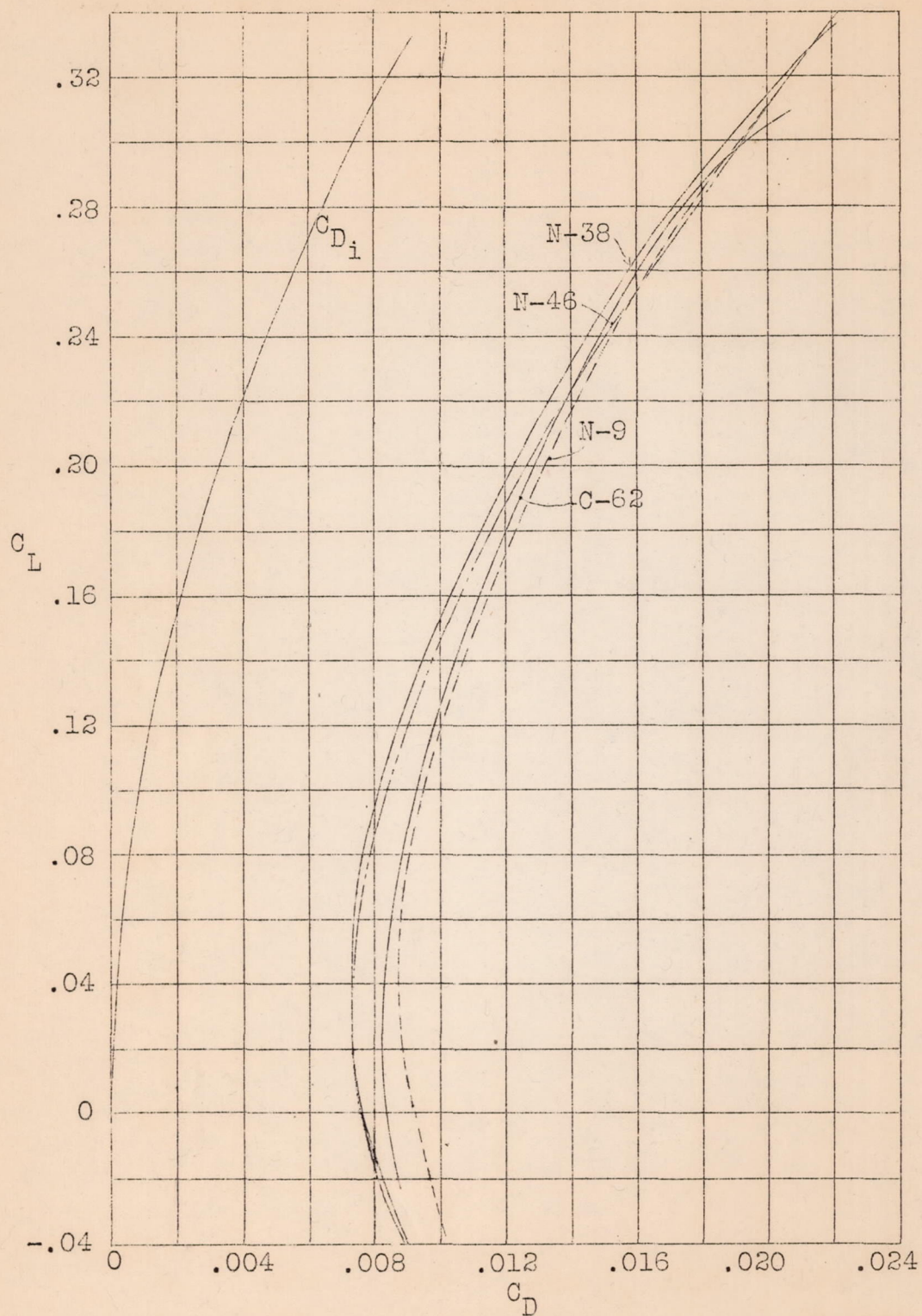


Fig.7

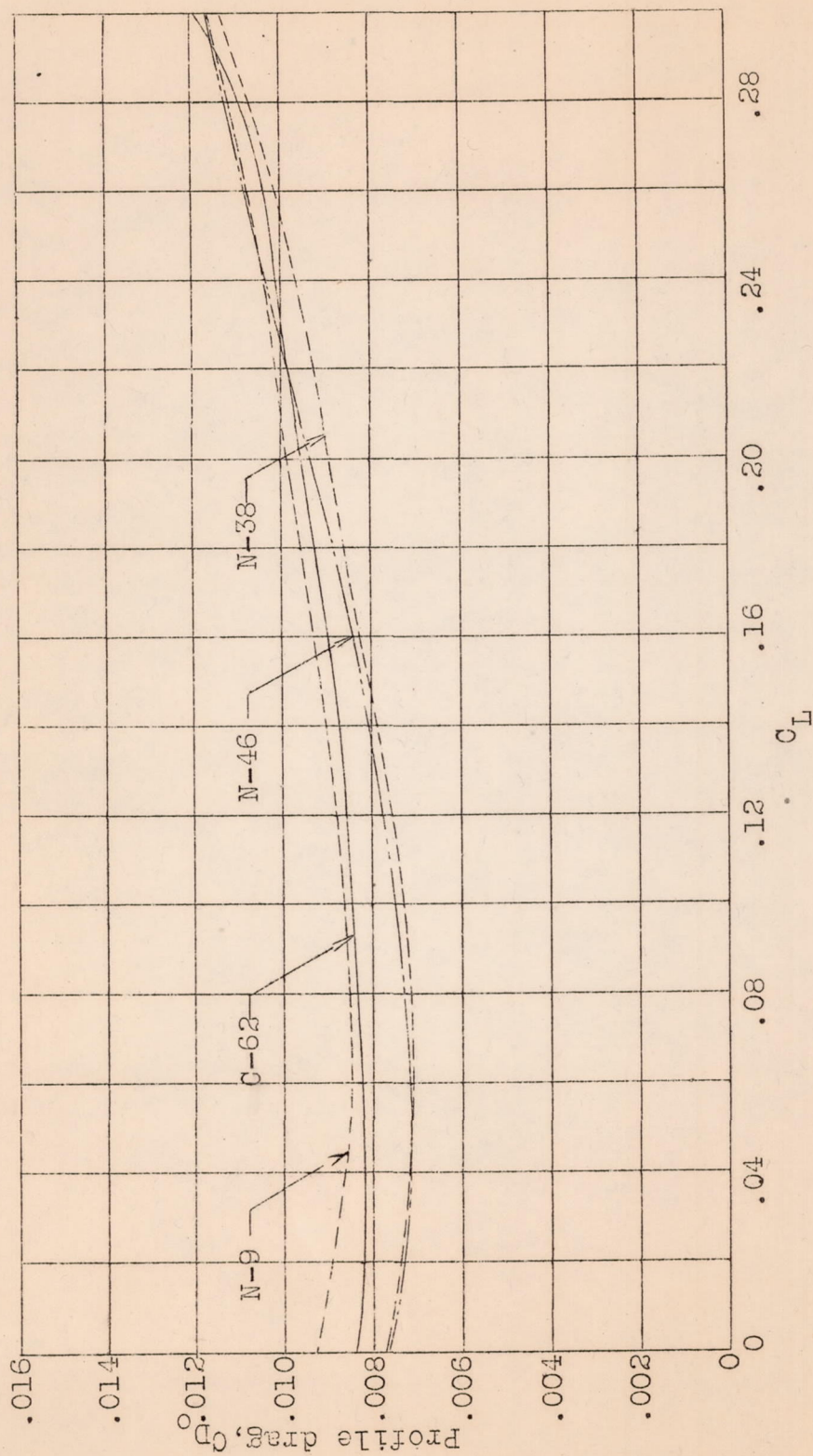
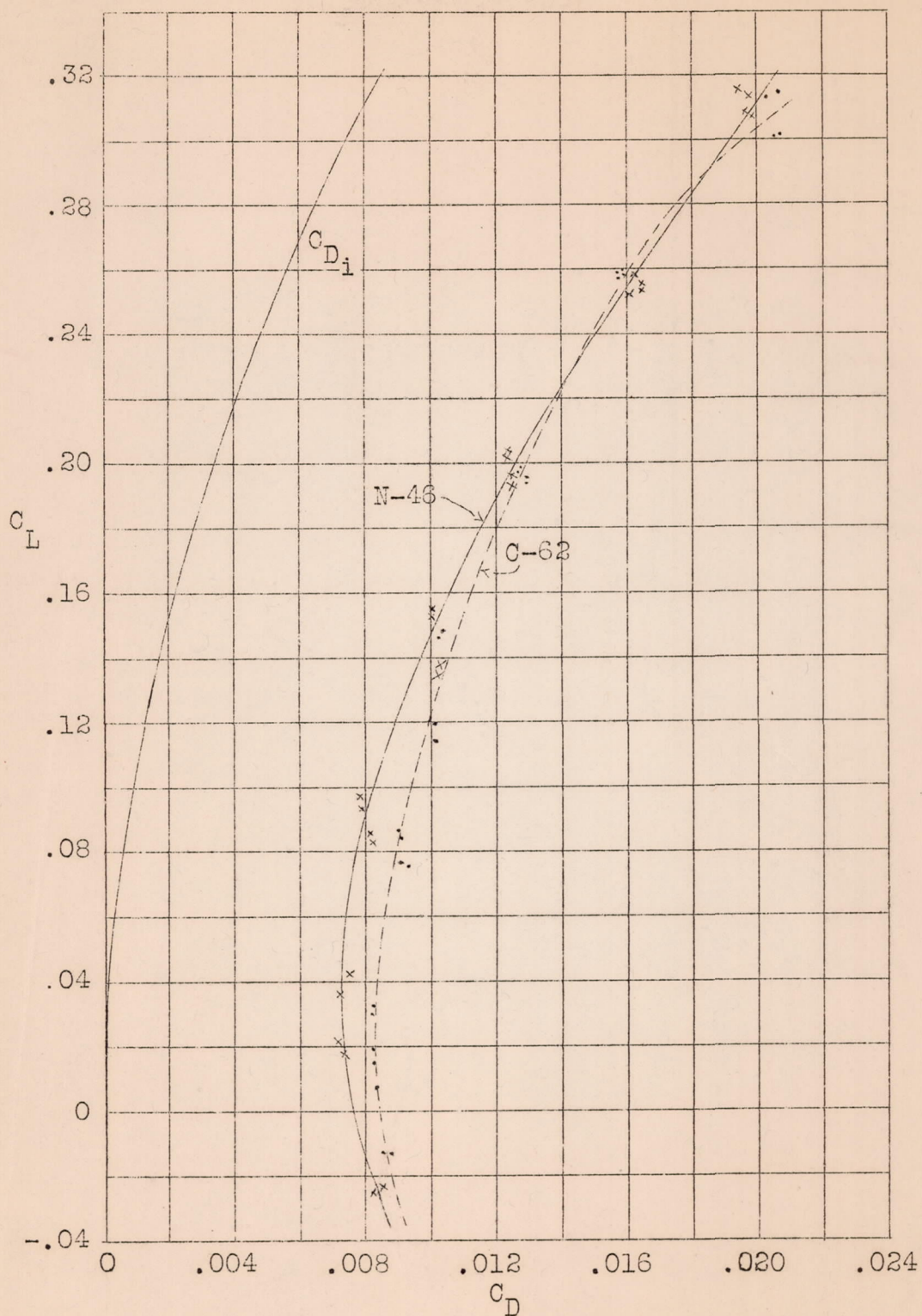


Fig.8

Fig.9 N-46 & C-62 airfoils. $S = 36$ sq.ft.